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MODEL OF DECAYING DARK ENERGY BASED ON THE KALUZA–KLEIN THEORY

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On the basis of a scalar potential associated with Beltrami's geometry – manifolds of constant negative curvature, the Klein–Gordon problem has been solved, making it possible, under the assumption of a physical structure of the fifth dimension (presumably a rich form of matter), to model on the basis of the Kaluza–Klein theory the hypothesis of decaying dark energy configuring the rates of expansion of the Universe.

Keywords: fifth dimension, dark energy, Beltrami surface, scalar field, scalar potential, deceleration parameter.

INTRODUCTION

In the opinion of many physicists, dark energy and dark matter, currently the subject of research at CERN [1], must be taken into account in studies of the microworld at the smallest distances [2, 3]. To test the inverse square law down to a scale of 44 μm, numerous different torsion balance experiments have been carried out [2, 3]. Their aim has been to achieve further penetration into the submillimeter range to probe the vacuum Casimir effect [4] and the *chameleon* effect as it pertains to dark energy; supersensitive sensors have been designed and constructed, in particular, for this purpose ($0.1\cdot10^{-12}$ N) [5]. As the end result, it is possible to predict (or rule out) the as-yet unknown fifth vacuum dimension, in regard to which the likelihood exists that its density is associated with the substance we call *dark energy*, admitting a slow decay with time [6]. This model should be compared, according to [6], with observations of high red shift type-1a supernovae [7, 8].

In foregoing studies [2, 3, 9, 10] the x^5 dimension was represented as the scale of a fluctuating substance – dark energy

$$\lambda^* = (\hbar / c\rho_{DE0})^{1/4},\ \lambda^* = 85\ \mu\text{m}, \tag{1}$$

where the initial density of dark energy is equal to $\rho_{DE0} = 0.673\cdot10^{-29}$ g/cm^3. A detailed derivation of this result can be found in [11]. Thus, according to Kaluza, the world has three spatial dimensions, one time dimension, and a fifth dimension [12] that is represented in general form as

$$x^5 = (m^*/m_0)\lambda \equiv (m^*c^2/c^2m_0)\lambda \equiv (\varepsilon^*/\varepsilon_0)\lambda$$

$$= (\rho_{DE}/\rho_{DE0})(\lambda/\lambda^*)^3\lambda,\ \lambda \le \lambda^*,\ x_0^5 = \lambda^*. \tag{2}$$

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